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Designing an ergonomic, versatile seat belt for blast-attenuating seats, ensuring protection for all body sizes. It must withstand extreme conditions, integrate with tactical gear, and be easy to operate. Safety, comfort, and reliability are key priorities.

VOL. 1 of 1

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Programme :
Bachelor of Design (B.Des)
Product Design

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- Description of the finalized seat, refined CAD models

Background: Importance of Blast Attenuation Seats in Vehicle Safety

Introduction to Blast Attenuation

Blast attenuation seats are critical in environments prone to explosive threats, such as military vehicles, armored personnel carriers (APCs), and mine-resistant ambush-protected (MRAP) vehicles.
 These systems provide a layer of protection against the devastating effects of explosions, particularly those caused by landmines and improvised explosive devices (IEDs).
The primary goal of a blast attenuation seat is to safeguard the occupant by reducing the forces transmitted through the vehicle's structure during an explosion.

The Physics of Explosions and Their Impact on Occupants
Explosions produce shockwaves and rapid pressure changes, capable of destroying vehicles and causing life-threatening injuries. The three main effects of an explosion on vehicle occupants are:

Shockwave Impact

Rapid pressure changes can lead to internal organ damage and traumatic brain injuries.

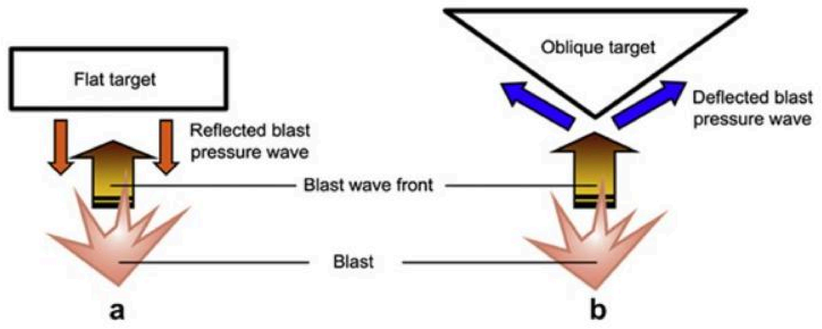
Ground Shock

The energy travels through the ground into the vehicle, causing vertical accelerations.

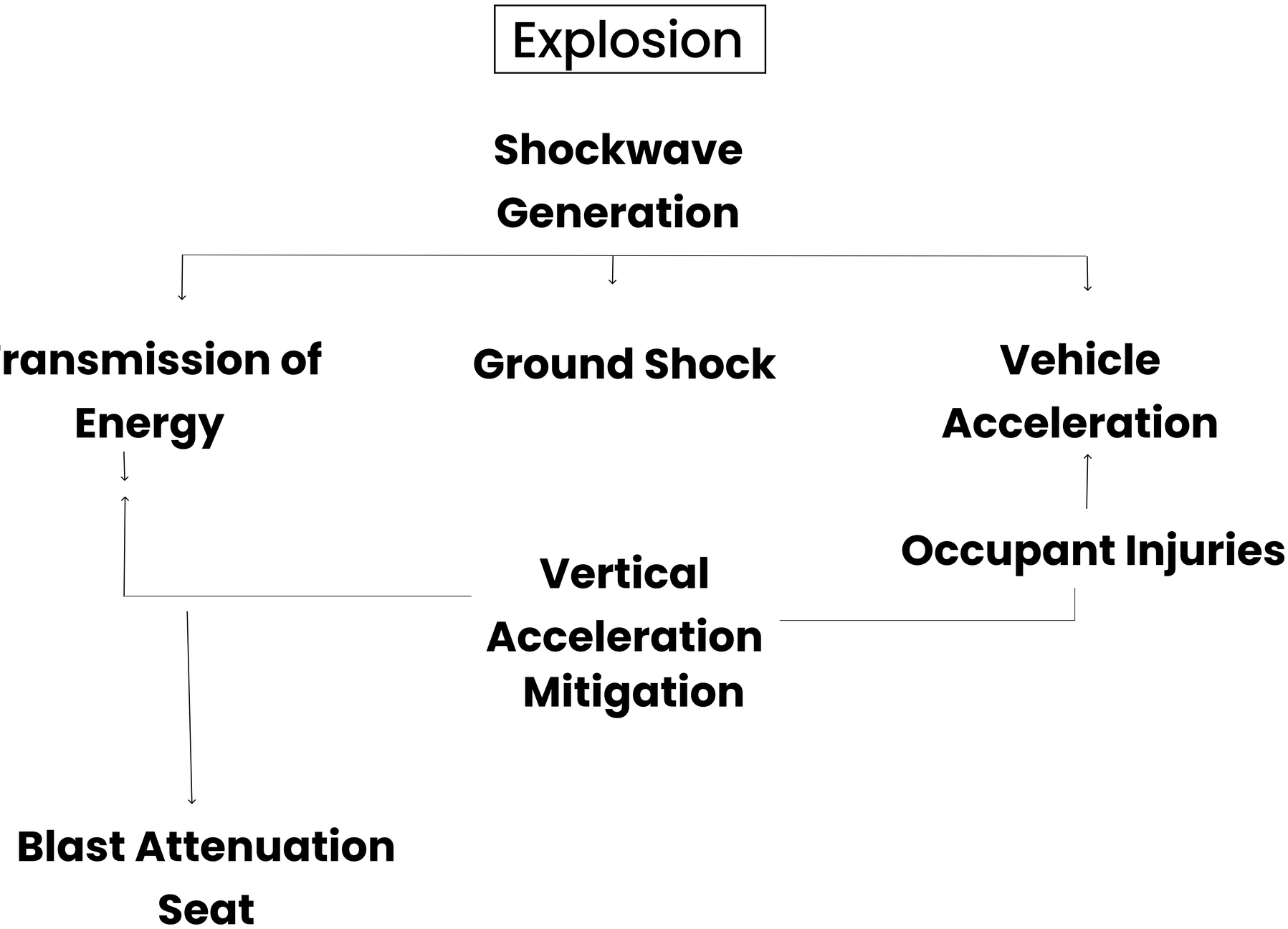
Vehicle Acceleration

Sudden movement can result in spinal compression and musculoskeletal injuries.

Fig. 2 Schematic illustration showing the effectiveness of the V-shape hull to deflect blast wave [12]



Effects of Explosions on Vehicle Occupants



Why Blast Attenuation Seats Are Necessary

Life-Saving Potential

By absorbing and redirecting energy, these seats minimize injury risks, particularly to the spine and lower extremities.

Enhancing Survivability

By absorbing and redirecting energy, these seats minimize injury risks, particularly to the spine and lower extremities.

Life-Saving Potential

By absorbing and redirecting energy, these seats minimize injury risks, particularly to the spine and lower extremities.

Historical Context

The need for blast protection became evident during World War II and subsequent conflicts, where traditional vehicle seating proved inadequate against landmine threats. Early designs focused on increasing vehicle armor but lacked occupant-specific solutions. By the late 20th century, advancements in engineering enabled the development of energy-absorbing materials and mechanisms specifically for seating systems.

Energy Absorption

Dissipating blast forces to reduce peak accelerations experienced by the occupant.

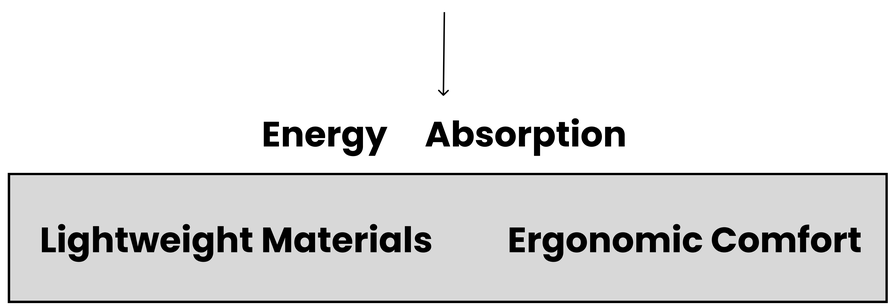
Ergonomics

Designing for comfort during normal operations while ensuring protection during blasts.

Material Optimization

Utilizing lightweight yet durable materials like Kevlar, carbon composites, and memory foam.

Objectives of Blast Attenuation Systems



Advances in Blast Attenuation Technology

Modern blast attenuation seats incorporate advanced technologies such as:

Suspension Systems

Springs and dampers that isolate the seat from vehicle vibrations and shocks.

Adaptive Materials

Materials that respond dynamically to forces, providing greater protection.

Modularity

Designs that allow for customization and repair, enhancing usability in diverse vehicle types

In the present-day landscape of asymmetric warfare, blast attenuation systems are critical for protecting soldiers and civilians. As IED attacks and landmine threats continue to evolve, these seats ensure that vehicles remain a safe operational base in hostile environments.

Objectives for Blast Attenuation Seat

1. Safety Enhancement

Develop a seat capable of effectively dissipating upward blast pressures to protect occupants.

2. Ergonomic Comfort

Develop a seat capable of effectively dissipating upward blast pressures to protect occupants.

3. Pressure Distribution

Create a mechanism to distribute forces evenly across the seat, reducing localized stress points.

4. Material Innovation

Incorporate advanced materials that combine shock absorption with durability and lightweight

5. Scalability

Design the seat for adaptability across various vehicle types and applications.

6. Enhanced Durability

Improve resistance to wear and tear by using abrasion-resistant fabrics and robust construction techniques.

7. Aesthetic Improvements

Modernize the seat design to make it visually appealing while maintaining its functional integrity.

8. Quick Adjustability

Add features like adjustable seat height, recline angles, or padding to cater to diverse occupant needs.

9. Safety Features

Integrate sensors or indicators that warn occupants about improper seat adjustments affecting pressure absorption.

10. Cost-Effective Manufacturing

Redesign components to simplify production, making the seat more affordable for widespread deployment

Exploration of Existing Blast Attenuation Seats

Introduction

Blast attenuation seats are vital safety components in tactical and armored vehicles, protecting occupants from upward forces generated by explosive devices like landmines and IEDs. Countries worldwide have developed unique solutions tailored to their military needs and operational contexts. This section explores and compares these solutions based on design, materials, safety mechanisms, and ergonomic considerations.

Military-Specific Blast Attenuation Seats

USA

Standards and Requirements → MIL-STD-1472; focuses on survivability and ergonomic design.

Popular Models → Advanced Lightweight Seats with Shock Absorption (e.g., BAE Systems).

Ejection seats with integrated blast mitigation.

Features → MIL-STD-1472; focuses on survivability and ergonomic design.

EUROPE

Standards and Requirements → NATO AEP-55; focused on blast overpressure protection.

Popular Models → Lightweight mine-resistant seats (e.g, Isringhausen).

Seats designed for troop carriers and APCs.

Features → Adjustable suspension systems.
Use of composite materials for durability.
Compatibility with body armor.

INDIA AND CHINA

Standards and Requirements → BIS standards in India for defense equipment.

Locally adapted NATO-inspired standards in China.

Popular Models → Blast seats by Tata Advanced Systems (India).

Indigenous designs by NORINCO (China).

Features → Cost-efficient materials like reinforced polymers.

Integrated shock absorbers beneath the seat base.

Designed for hot and humid climates.

MIDDLE EAST

Standards and Requirements → Adaptation of NATO or US standards.

Popular Models → Armored vehicle seats by Streit Group.

Features → Weather-resistant designs.

High durability for harsh desert environments.

Blast Attenuation Seat Structure, Placement, and Layout

1. Structural Composition

Frame Materials

Steel — High durability, withstands extreme loads.

Aluminum — Lightweight, corrosion-resistant.

Composite materials — Carbon fiber or Kevlar for strength-to-weight efficiency.

Hybrid structures — Combination of metals and composites for optimized performance

Cushioning

High-density foam — Energy absorption and comfort.

Gel padding — Enhanced shock absorption.

Memory foam — Custom fit and pressure distribution.

Air bladders — Combination of metals and composites for optimized performance

Suspension Systems

Spring-based systems — Absorbs vertical and horizontal shock.

Elastomer dampers — Reduces vibrations and recoil.

Hydraulic systems — Carbon fiber or Kevlar for strength-to-weight efficiency.

Magnetor-heological fluids — Combination of metals and composites for optimized performance

2. Placement Options

Vehicle-specific Placements

Driver seats — Maximum focus on visibility and ergonomics.

Passenger seats

Rear compartments — Prioritized for troop safety in armored vehicles.

Modular Installations

Wall-mounted — Space-saving designs for compact interiors.

Floor-mounted — Enhanced stability and load distribution.

Ceiling-suspended — Innovative solutions for vibration isolation.

Adaptability

Foldable designs — Saves space when not in use.

Rotational bases — Enhanced mobility for quick exit or operational shifts.

Quick-release mechanisms — Facilitates rapid detachment during emergencies.

3. Seat Layout Designs

Single Seat Designs

1. Focused shock absorption for individual users.
2. Customized for specific roles like drivers or gunners.

Bench Seating

1. Accommodates multiple passengers.
2. Enhanced lateral support for group safety.

Configurable Seating

1. Modular layouts to switch between cargo and personnel transport.
2. Adjustable seat spacing for varying troop sizes.

Reclining Mechanisms

1. **Manual recline**: Simplistic and durable.
2. **Powered recline**: Comfort-focused designs for prolonged missions.
3. **Locking mechanisms**: Stability during dynamic movements.

Manufacturing companies for blast Attenuation seat in India and world

1. INDIA

Timetooth Technologies	Rotax Electronics
Specialization	**Specialization**
Blast-resistant seats for mine-protected vehicles.	Driver and co-driver blast seats.
Details	**Details**
Develops mine blast-resistant seats (MBRS) with high shock absorption efficiency, attenuating accelerations from over 100g to less than 15g.	Provides customized driver blast seats to protect occupants of tracked and wheeled combat vehicles from the effects of roadside IEDs or mine blasts.

2. Canada

Med-Eng

Specialization

Blast attenuation seats for various military vehicle roles.

Details

Offers a range of seats, including driver, commander/ gunner, and troop/crew seats, designed to protect occupants from blast effects.

3.Israel

Plasan

Specialization

Driver and co-driver blast seats.

Details

Developed the TERRA™ line of energy-attenuating seats, designed to absorb and reduce kinetic energy from explosions, enhancing crew survivability.

4. USA

Armor Works	SKYDEX
Specialization	**Specialization**
Seating systems for blast protection.	Blast mitigating decking and seat cushions.
Details	**Details**
Provides seating systems that protect soldiers from blast effects caused by land mines and IEDs, with installations in over 10,000 operational vehicles worldwide.	Designs and manufactures blast mitigating decking and mats, as well as energy-absorbing layers for blast seat cushions to enhance performance.

5. TURKEY

T-Kalip

Specialization

Mine blast attenuating seating systems.

Details

Supplies AEP-55 standard combat-proven mine blast attenuating seating systems for defense vehicles.

6.UNITED KINGDOM

Quantum Seating

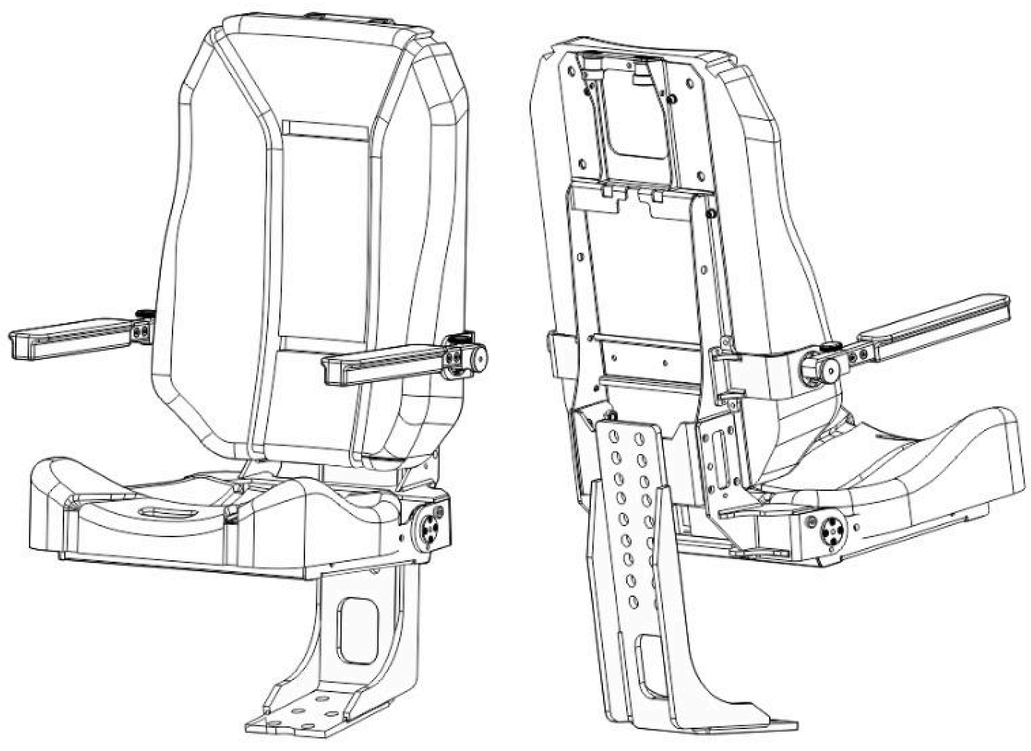
Specialization

Defense seating solutions.

Details

Offers anti-blast seats and rollover protection seats in service worldwide, with all products designed and manufactured in the UK.

Problem Areas



1. Comfort vs. Safety

Problem

Balancing comfort for long durations and safety during a blast can be challenging

Example

Overly rigid seats for blast protection may cause discomfort during regular operations.

2. Weight and Bulk

Problem

Blast attenuation seats often add weight to the vehicle and may be too bulky for compact spaces.

Example

Increased seat weight can affect fuel efficiency and payload capacity.

3. Complex Harness Systems

Problem

Five-point harnesses can be difficult to secure quickly under time pressure..

Example

Soldiers might take longer than expected to buckle up during emergencies.

4. Limited Blast Energy Absorption

Problem

The seat may fail to absorb sufficient energy from high-magnitude blasts.

Example

Springs or dampers might bottom out or fail under extreme conditions.

5. Maintenance and Durability

Problem

Moving parts like springs and dampers require frequent maintenance in harsh environments.

Example

Sand, dirt, and wear can degrade performance over time.

6. Post-Blast Resetting

Problem

Seats may not reset quickly after absorbing a blast.

Example

Damaged components can prevent reusability, impacting operational readiness.

7. Cost Constraints

Problem

High-end materials and technology can make the seats prohibitively expensive.

Example

Budget limitations in mass production may compromise on quality.

8.Vibration and Noise

Problem

Seats designed for blast protection may amplify vibrations during regular vehicle movement.

Example

Soldiers experience fatigue or discomfort due to constant vibration.

Types Of Seat Belt And Their Pros And Cons For Blast On Truck In Different Areas In Which Will Affect The Solider

1. Four Point Harness

Description

Features two shoulder straps and two lap belts, all meeting at a central locking mechanism.

Advantages

1. Provides a secure fit, reducing occupant movement.
2. Ensures better load distribution across the chest and Hip during a blast.
3. Easy to adjust and lock securely.

Disadvantages

1. Limited comfort for long-term use.
2. Complex to put on compared to traditional three-point belts.

2. Five Point Harness

Description

Includes the features of a four-point harness with an additional strap between the legs to prevent submarining (sliding under the lap belt).

Advantages

1. Offers maximum restraint during vertical and horizontal impacts.
2. Excellent protection against forward and upward forces.

Disadvantages

1. Limited comfort for long-term use.
2. Complex to put on compared to traditional three-point belts.

3. Six Point Harness

Description

Similar to the five-point harness but with two leg straps instead of one for improved stability.

Advantages

1. Superior load distribution compared to other systems.
2. Reduces the risk of concentrated pressure points.

Disadvantages

1. Complicated to fasten and adjust.
2. Expensive compared to simpler systems.

4. Dynamic Blast-Responsive Harness

Description

Features energy-absorbing materials or mechanical systems to dissipate blast energy.

Advantages

1. Actively reduces the force transmitted to the occupant.
2. Can adapt to the intensity of the blast.

Disadvantages

1. Heavy and bulky.
2. Requires precision engineering, leading to high costs.

1. Blast from Below (Under-Vehicle Blast)

Blast Dynamics

1. A blast from beneath the truck produces upward forces.
2. The explosive shockwave interacts with the vehicle floor, resulting in rapid vertical acceleration.

Risk to occupant

1. Spinal compression, Hip injuries, and leg trauma due to the direct transfer of forces.

Affected Body Areas

1. Spine: High risk of compression injuries.
2. Hip: Experiences concentrated upward forces.
3. Lower Limbs: Potential for injuries due to floor deformation and shockwave transmission.

Seat Belt Response

Seat Belt Type	Performance
Four-Point Harness	Offers decent torso (the central part of the human body that connects the head, neck, arms, and legs) restraint but limited lower-body stability.
Five-Point Harness	Superior to the four-point harness; adds pelvic restraint, reducing upward motion.
Dynamic Harness	Absorbs and redistributes the vertical energy dynamically, reducing transmitted forces to the spine.

Advantages/Disadvantages of Seat Belts

Seat Belt Type	Advantages	Disadvantages
Four-Point Harness	Effective at minimizing pelvis displacement and distributing forces.	Crotch strap might cause discomfort or pressure injuries in extreme blasts.
Five-Point Harness	Provides excellent lower-body stability; minimizes spinal and Hip injuries.	Bulky and may take slightly longer to secure.
Dynamic Harness	Adapts dynamically, reducing transmitted forces; ideal for unpredictable vertical shocks.	Complex system; requires advanced materials and technology.

2. Blast from the Side (Left or Right Flank of the Truck)

Blast Dynamics

1. A side blast creates lateral forces that push the occupant sideways.
2. The blast wave interacts with the side of the vehicle, causing deformation and tilting.

Risk to occupant

1. Torso, shoulder, and pelvic injuries due to lateral displacement.

Affected Body Areas

1. Spine: High risk of compression injuries.
2. Hip: Experiences concentrated upward forces.
3. Lower Limbs: Potential for injuries due to floor deformation and shockwave transmission.

Seat Belt Response

Seat Belt Type	Performance
Five-Point Harness	Provides moderate restraint against lateral forces; shoulders and torso are stabilized.
Six-Point Harness	Adds lower-body restraint, preventing twisting and excessive torso movement.
Dynamic Harness	Dynamically adjusts tension to counter lateral displacement; minimizes torso and Hip movement.

Advantages/Disadvantages of Seat Belts

Seat Belt Type	Advantages	Disadvantages
FIve-Point Harness	Stabilizes the upper body against lateral displacement.	Limited Hip and lower body stabilization; torso twisting can occur.
Six-Point Harness	Superior torso and pelvic restraint; prevents twisting and provides excellent force distribution.	Bulky and less comfortable in confined spaces.
Dynamic Harness	Automatically adjusts to counter lateral forces; enhances occupant safety during side blasts.	Complex system; requires advanced materials and technology.

3. Rear Blast (Blast at the Back of the Truck)

Blast Dynamics

1. The blast wave pushes the vehicle forward, throwing occupants against the seatback.

Risk to occupant

Spinal compression, Hip injuries, and leg trauma due to the direct transfer of forces.

Affected Body Areas

1. Head and Neck: At risk of whiplash.
2. Chest and Abdomen: Can experience high compression forces.
3. Spine: Risk of strain from backward bending.

Seat Belt Response

Seat Belt Type	Performance
Four-Point Harness	Stabilizes the torso and shoulders but offers limited lower body restraint.
Six-Point Harness	Stabilizes both the chest and pelvis, reducing forward displacement of the lower body.
Dynamic Harness	Adjusts tension dynamically to reduce the impact forces on the chest and pelvis.

Advantages/Disadvantages of Seat Belts

Seat Belt Type	Advantages	Disadvantages
Five-Point Harness	Reduces forward displacement; provides balanced stabilization of chest and Hip.	Slightly slower to release in emergencies.
Six-Point Harness	Absorbs impact energy; reduces injuries to chest and abdomen.	Requires advanced technology; higher initial costs.
Dynamic Harness	Adjusts automatically to changing force vectors; minimizes transmitted forces.	Requires sophisticated engineering and maintenance.

4. Frontal Blast (Blast at the Front of the Truck)

Blast Dynamics

1. The blast wave pushes the vehicle backward, pressing occupants into the seat.

Risk to occupant

Spinal compression, neck strain, and head injuries.

Affected Body Areas

1. Chest: Compressed against the seatbelt or seat.
2. Spine: Subject to strain from sudden backward motion.
3. Hip: Stabilized, reducing lower body injuries

Seat Belt Response

Seat Belt Type	Performance
Four-Point Harness	Provides adequate stabilization for the torso and shoulders.
Five-Point Harness	Superior to the four-point harness; adds pelvic restraint, reducing upward motion.
Dynamic Harness	Dynamically absorbs backward forces, minimizing transmitted energy to the spine and torso.

Advantages/Disadvantages of Seat Belts

Seat Belt Type	Advantages	Disadvantages
Five-Point Harness	Provides balanced protection for chest and pelvis.	May cause discomfort during prolonged use.
Dynamic Harness	Automatically adapts to forces, reducing injury risk.	Complex system requiring frequent checks.

5. Overhead Blast (Blast Above the Truck)

Blast Dynamics

1. Downward forces compress the truck and the occupants.

Risk to occupant

1. Spinal compression, neck strain, and head injuries.

Affected Body Areas

1. Spine: High risk of compression injuries.
2. Neck: Strain from downward forces.
3. Shoulders: Subject to high pressure.

Seat Belt Response

Seat Belt Type	Performance
Six-Point Harness	Stabilizes the chest, Hip, and thighs; distributes forces to minimize spinal compression.
Dynamic Vertical Harness	Absorbs and redistributes downward energy, reducing transmitted forces.

Advantages/Disadvantages of Seat Belts

Seat Belt Type	Advantages	Disadvantages
FIve-Point Harness	Superior vertical stabilization; minimizes spinal injuries.	Bulky and takes longer to secure.
Dynamic Harness	Reduces transmitted forces dynamically; protects sensitive areas.	Complex and expensive.

Neck-Cutting Issues in Blast Attenuation Seat Belt

1. Causes	
Material Design	1.Rough or abrasive edges on straps. 2.Use of non-softened webbing materials.
Improper Fit	1.Misaligned straps causing rubbing or chafing. 2.Excessive slack allowing the belt to shift onto the neck.

2. Consequences	
Physical Damage	1.Skin abrasions or lacerations. 2.Pressure-induced neck strain. 3.Potential for long-term discomfort or scarring.
Operational Inefficiency	1.Frequent maintenance or redesign requirements. 2.Decreased soldier morale in high-stress environments.

3. Potential Solutions

Material Improvement

1.Rough or abrasive edges on straps.
2.Use of non-softened webbing materials.

Padding Intergation

1.Adding foam or gel-based neck protectors.
2.Use of detachable, washable padding covers.

4.Design Considerations

Aesthetic Enhancements

1.Use non-intrusive designs that blend with military aesthetics.

Ease of Maintenance

1.Incorporate easily replaceable components

Design outputs for a blast attenuation seat belt harness

1. Material Specifications

High-tensile Strength Webbing

Designed to withstand significant forces.

Abrasion-Resistant Coatings

Extends the durability of the harness under harsh conditions.

Fire-Resistant Materials

For military-grade applications.

2. Safety Features

Energy-Absorbing Mechanisms

Reduces impact forces during a blast.

Load Distribution System

Prevents concentrated pressure points on the body.

Quick Release System

Allows for rapid evacuation in emergencies.

3. Ergonomics

Adjustable Straps

Ensures a snug fit for users of varying sizes.

Padded Components

Adds comfort for prolonged use.

Flexible Configurations

Adapts to different seating environments.

4. Compatibility

Integration with Seat Structure

Works seamlessly with the overall seat design.

Universal Fit Design

Can be used across different vehicle models.

Fire-Resistant Materials

For military-grade applications.

5. Mechanisms

Roller Coaster-Style Locking System

Reduces impact forces during a blast.

Dynamic Tensioning

Automatically adjusts based on movement or external forces.

Dual-Locking Buckles

Redundancy for enhanced security.

6. Usability

Intuitive Adjustment Points

Simple to use under stress.

Lightweight Construction

Reduces user fatigue.

Markings for Proper Fit

Ensures correct usage every time.

7. Aesthetic Considerations

Color Coding for Functions

E.g., quick release marked in bright colors.

Military Camo Patterns

Blends with vehicle interiors.

Low-Reflective Surfaces

Reduces visibility under night operations.

8. Testing and Validation

Impact Force Tests

To evaluate energy absorption efficiency.

Environmental Stress Tests

Assesses performance under extreme temperatures and conditions.

User Feedback Trials

Incorporates real-world usability data.

Design Brief

Designing a highly functional, ergonomic, and versatile seat belt system that provides maximum protection to occupants of blast-attenuating seats in military vehicles . The design must accommodate users of various body sizes, withstand extreme conditions, and integrate seamlessly with tactical gear while ensuring ease of operation.

Features

1. Adjustability and Fit

Range of Adjustability

1. Shoulder Straps: Adjustable to fit users of varying torso lengths (e.g., 400–600 mm).
2. Waist Straps: Extendable from 700–1,500 mm to accommodate users of different body sizes (thin to obese individuals).

Automatic Adjustment

1. Integrated auto-retractors to tighten slack without manual intervention.
2. Sensor-based tension adjustment to ensure proper grip on the user without over-tightening.

Customizable Components

1. Shoulder Straps: Adjustable to fit users of varying torso lengths (e.g., 400–600 mm).
2. Waist Straps: Extendable from 700–1,500 mm to accommodate users of different body sizes (thin to obese individuals).

2. Neck Protection

Soft Neck Padding

1. Memory foam or gel-filled pads to prevent the belt from digging into the neck.
2. Removable and washable padding for hygiene.

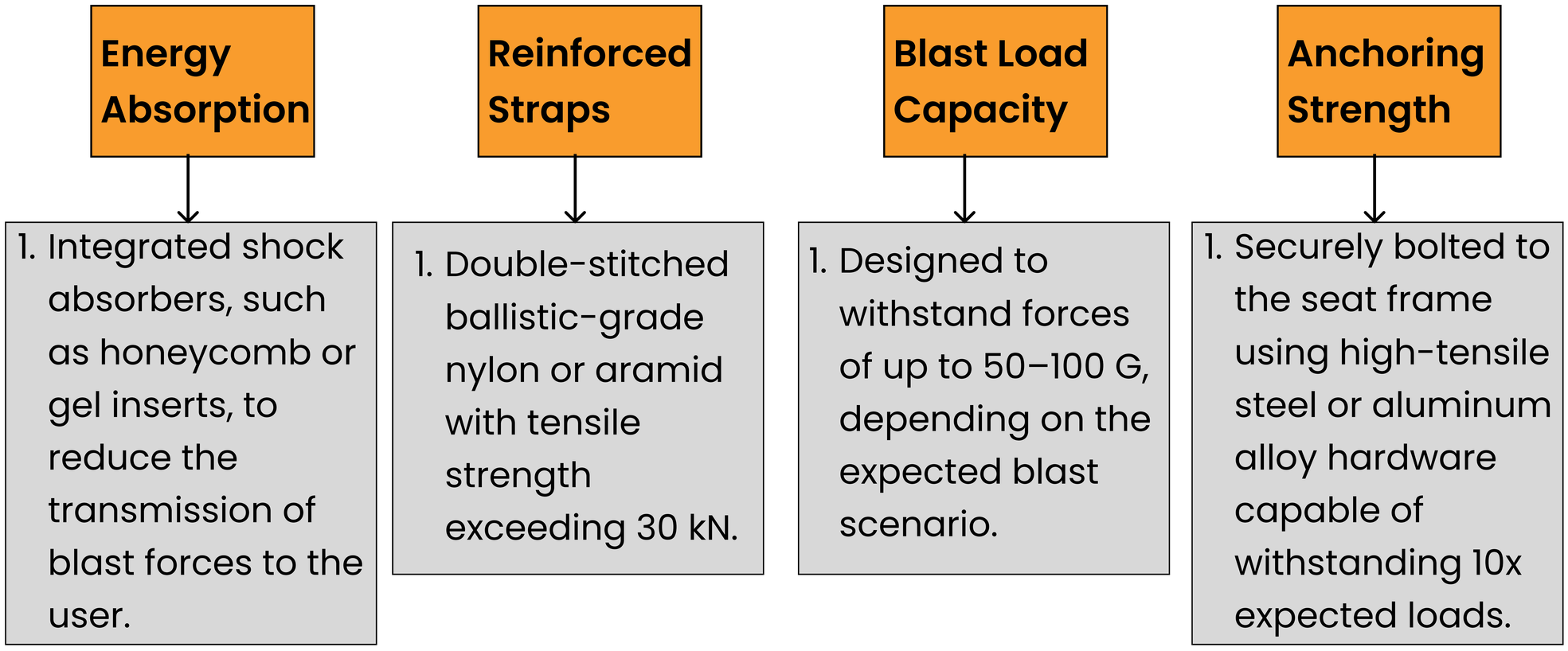
Wide Shoulder Straps

1. Wider straps near the neck to distribute force over a larger area.
2. Contoured design to avoid chafing during sudden movements.

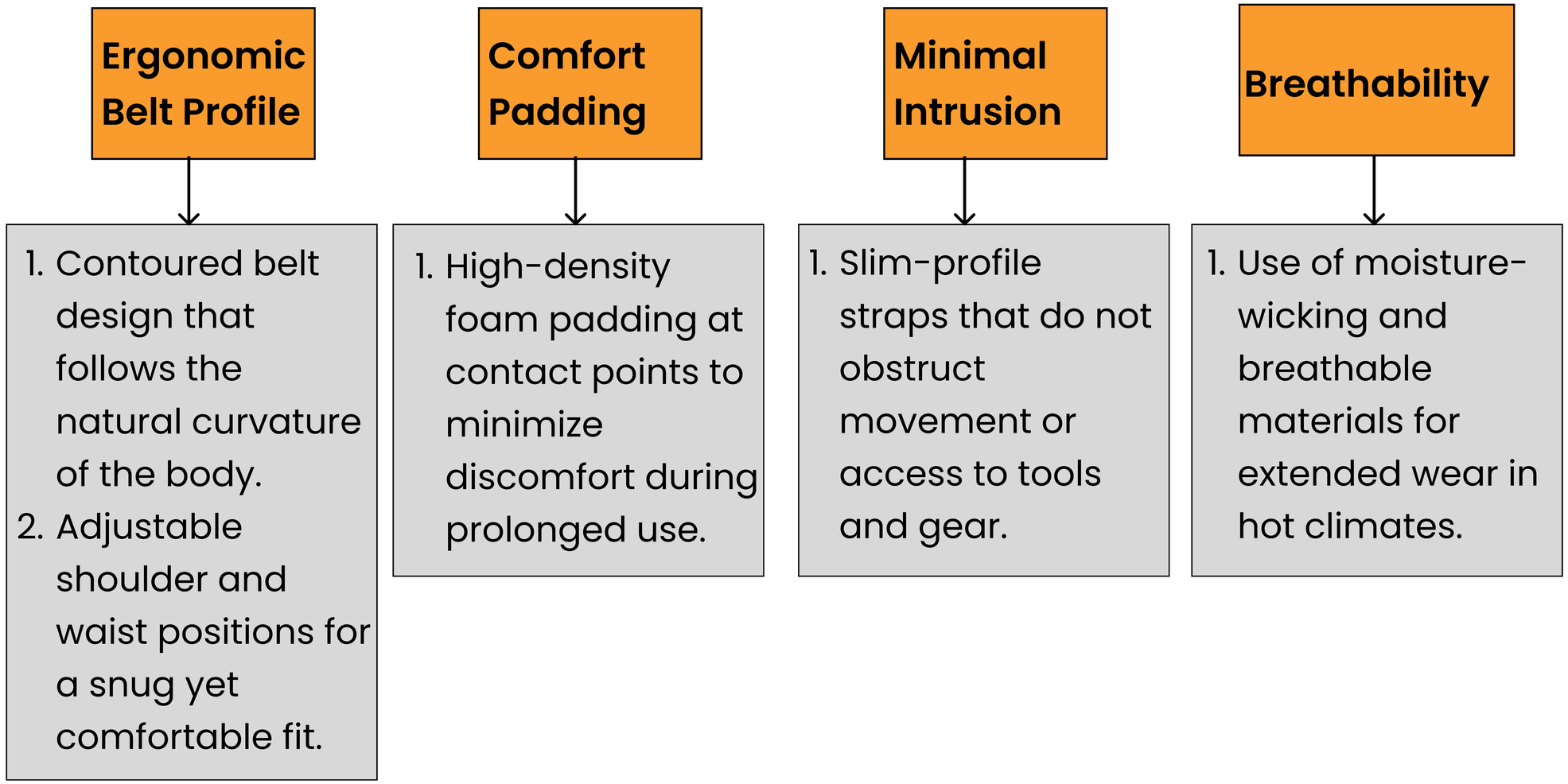
Protective Layers

1. Fire-retardant and abrasion-resistant material near the neck area.

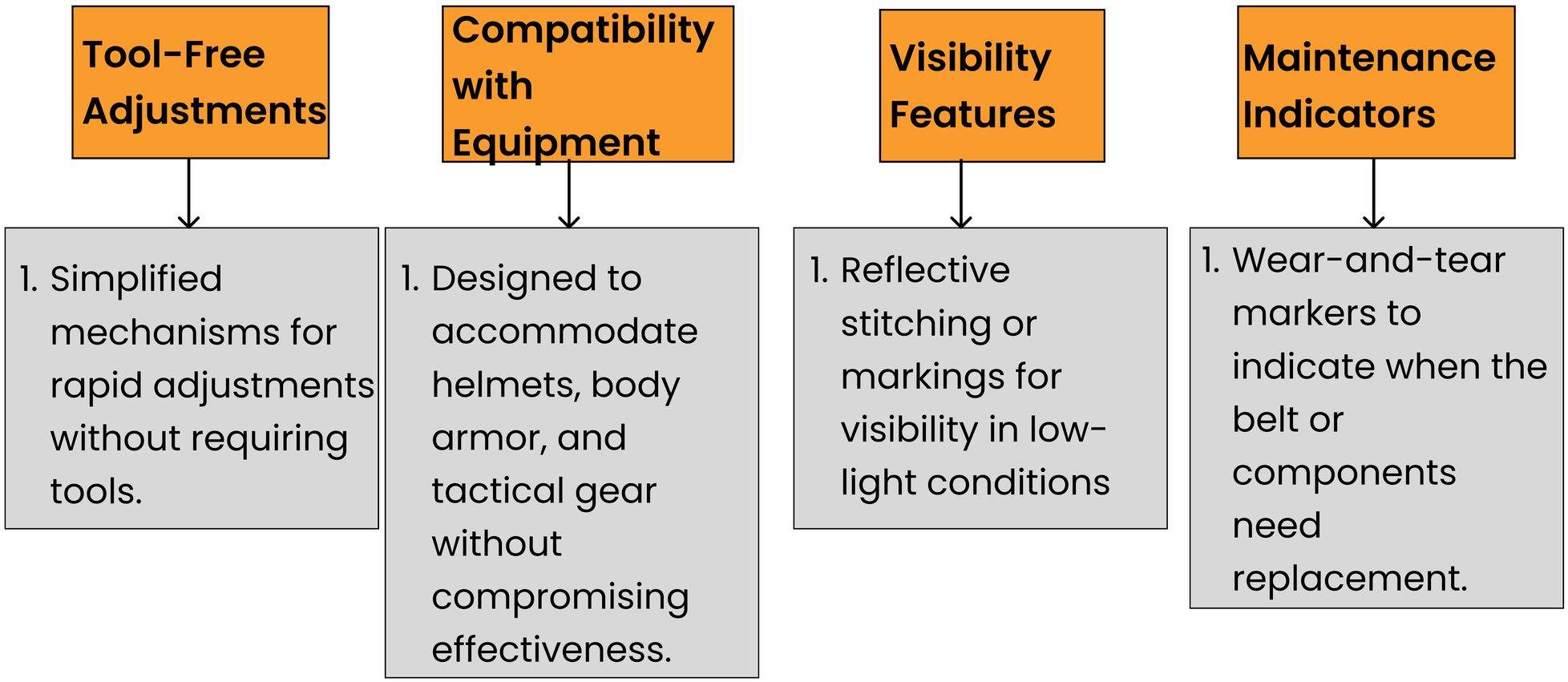
3. Blast Resistance



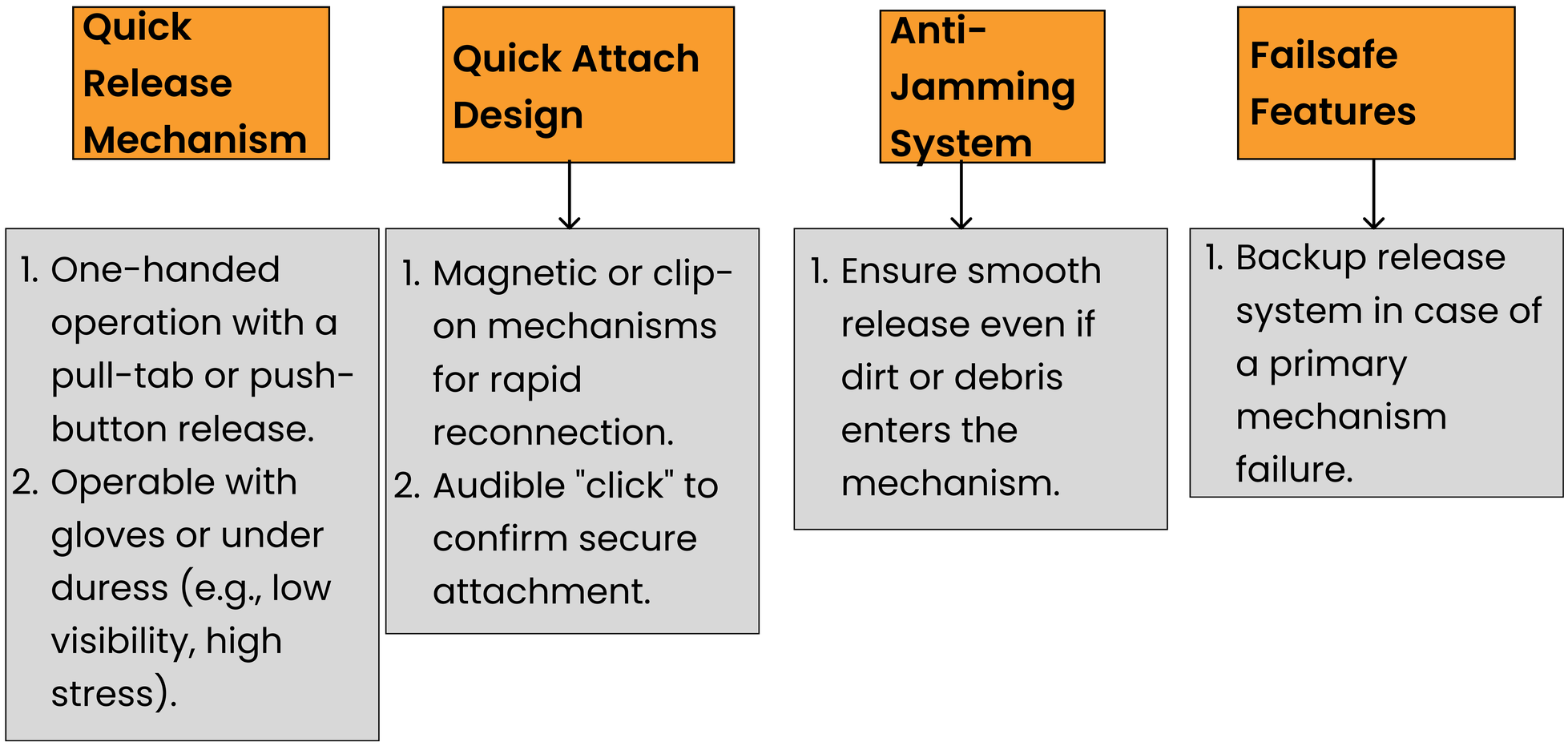
4. User Ergonomics



5. Operational Features



6. Quick Release and Attach of Seat Belt



CONCEPT SKETCHES FOR BLAST ATTENUATION SEAT BELT

CONCEPT -1



Integrated Safety Features

Includes neck protection with a cushioned headrest, fire-resistant materials, and optional airbags for added security.





Adjustable Fit and Comfort

Enables height, lumbar, and harness adjustments with ergonomic cushioning for long-term usability.



Quick-Release Mechanism

Features a one-click seatbelt release and magnetic buckles for rapid egress during emergencies.

CONCEPT -2



Adaptive Cushioning System

Pressure-sensitive foam adjusts to body contours for superior comfort and impact absorption.



Compact Foldable Design

Allows for easy storage or conversion to increase space within the vehicle when not in use.





Smart Safety Alerts

Built-in sensors to monitor impact levels and alert occupants during extreme blast or crash scenarios.



Integrated Harness Management

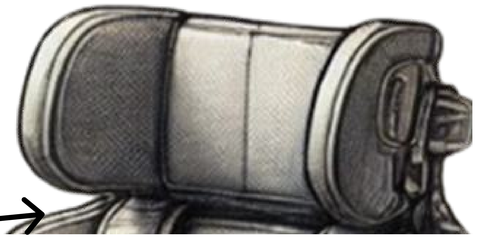
Self-tensioning seatbelts with intuitive quick-release points for efficient and secure restraint.

CONCEPT -3



User-Friendly Adjustments





Neck and Spine Safety

Integrated shock-absorbing headrest and neck guard to prevent injuries during high-impact events.



Quick Deployment

Fast attachment and detachment features for seamless seat installation and removal in vehicles.

CONCEPT -4







Ergonomic Design for Comfort

The harness incorporates padded straps with adjustable lengths for a customized fit.

Enhanced Restraint for High Impact

The 4-point harness evenly distributes the forces of a blast impact

CONCEPT -5



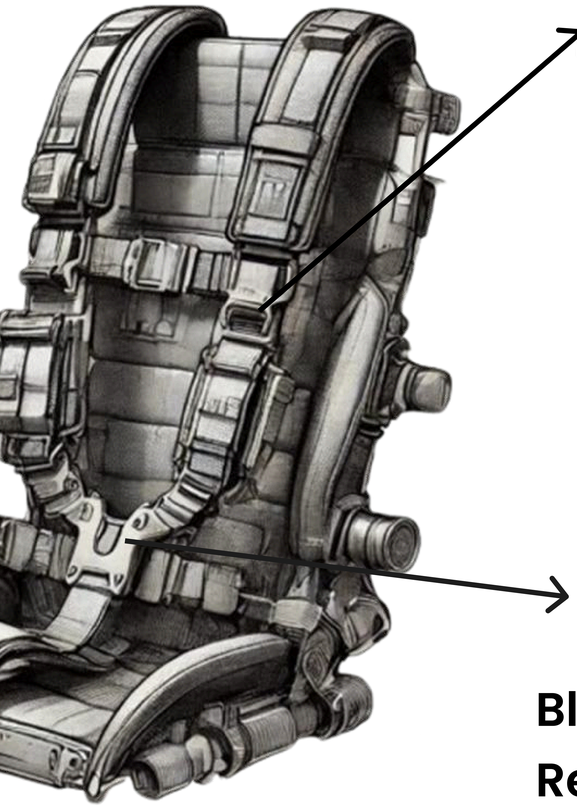
Anti-Twist Strap Technology

Features straps with anti-twist guides to maintain proper alignment and reduce entanglement risks during motion.



Superior Restraint

Enhances occupant stability and minimizes the risk of spinal or lower-body injuries during extreme vertical accelerations.





Adaptive Fit for Gear Integration

Adjustable design accommodates various body sizes and integrates seamlessly with tactical gear, exoskeletons, or heavy body armor.



Blast-Optimized Quick-Release Mechanism

A centrally located quick-release system with reinforced locking to withstand high-G forces while remaining accessible under stress.

Finalizing one concept by using parameters

(Concept - 5 has been finalized using by the using this parameters)

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
1.Adjustability and Fit	7	6	8	8	9
2.Neck Protection	5	5	7	6	9
3. Blast Resistance	6	6	8	7	8
4.User Ergonomics	5	6	7	6	8
5.Operational Features	5	5	6	7	8
6. Quick release and attach of seat Belt	6	6	8	8	8
7.Safety Enhancements	6	5	7	6	7
	40	39	51	48	57

Ergonomics for 5-Point Harness Seatbelt

Comfort

1. Soft, breathable padding on straps to reduce chafing.
2. Adjustable tensioning system for a snug, yet non-restrictive fit.
3. Curved strap design to follow natural body contours.

Safety

1. Optimized strap width to distribute forces evenly during blasts.
2. Anti-slip material on straps to prevent slippage in sudden impacts.

Ease of Use

1. One-hand quick-release buckle mechanism for efficiency.
2. Color-coded straps or intuitive markings for easy donning.
3. Smooth gliding material to minimize strap adjustments.

Accessibility

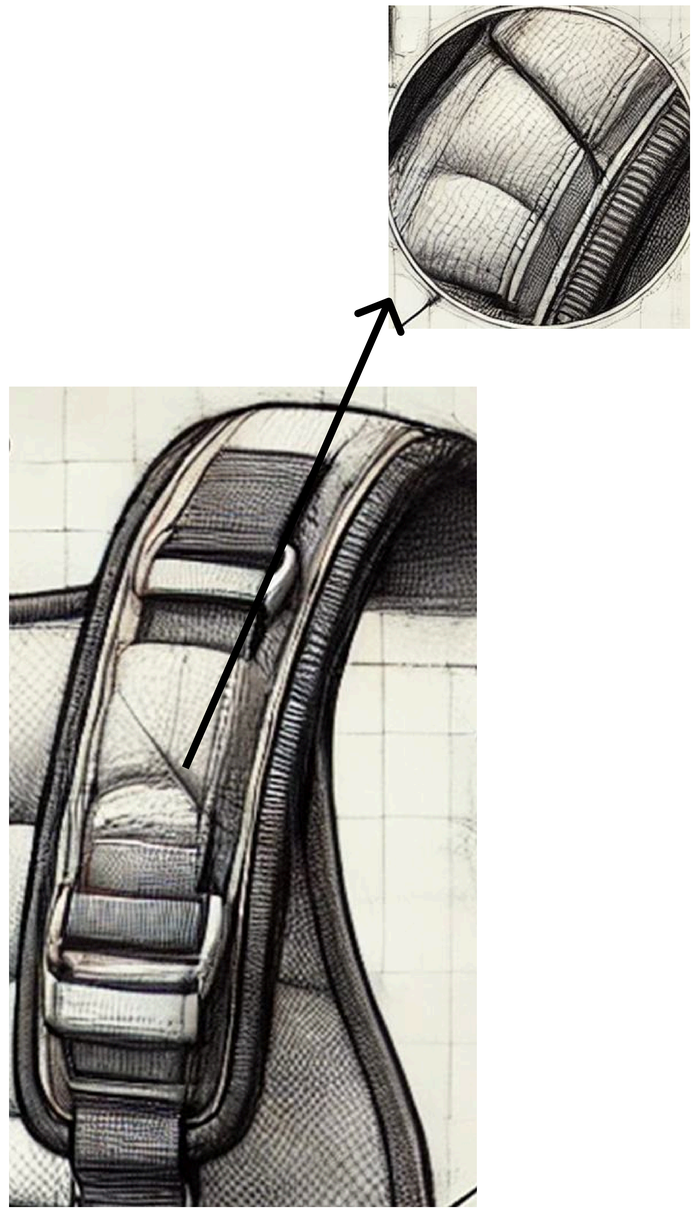
1. Adjustment handles positioned for easy reach, even with gloves.
2. Inclusive design for different body sizes and shapes.

Maintenance -Friendly

1. Removable and washable padding covers.
2. High-durability materials resistant to abrasion and wear.

Detailed Parts View Of Finalized Concept

1. Paddling and Comfort Features



Shoulder Pads	Foam or gel filled covers for shoulder straps to reduce pressure and increase comfort
Material	Soft yet durable fabric, such as neoprene or microfiber

2. Adjusters

Purpose	Allow a Lenght Adjustments to achieve a Snug Fit
Material	Heated Treated Steel or Aluminum With Anti-corrosion Coating.



3. Stitching

Thread

High Strength Nylon or Polyester Thread

Material

Zig-zag or Bar tack Stitching to ensue even load and distribution and prevent webbing failure



4. Straps and Webbing

Material	High Strength Polyester or Nylon Webbing (2 or 3 inch wide)
Specification	Minimum 6,000 lbs Breaking Strength



Components

Shoulder Straps (2)

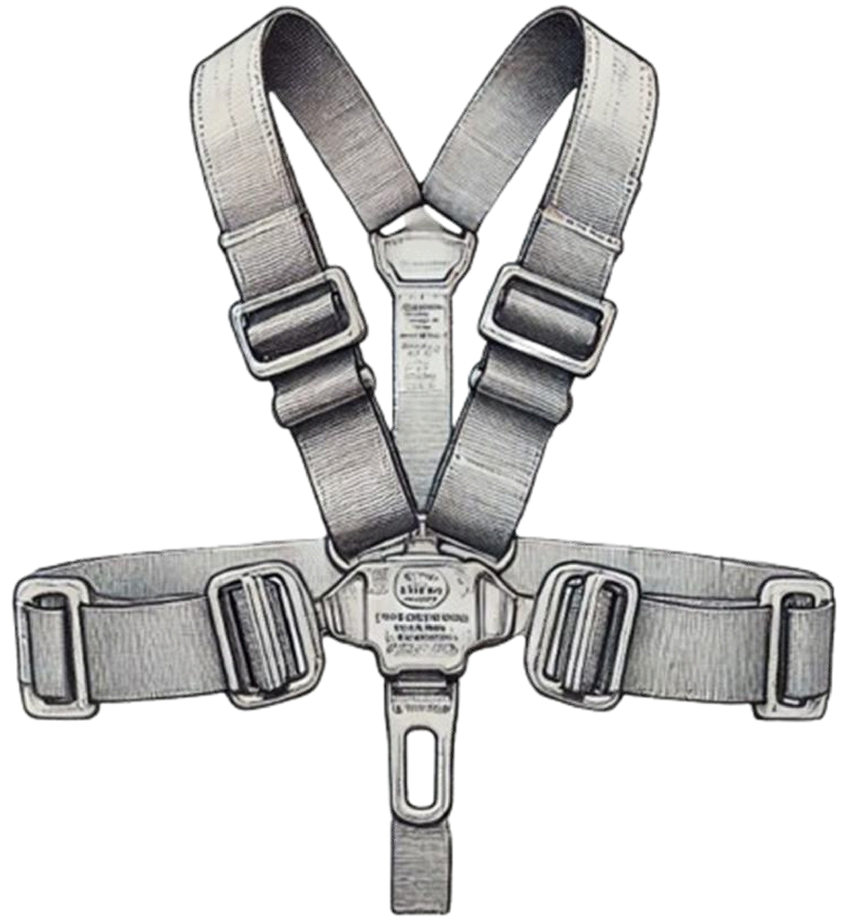
Extend from the shoulder to buckle, securing the upper body. This must be adjustable for the proper fit.

Lap Straps (2)

Anchor around the waist to secure the lower body

Submarine Straps (2)

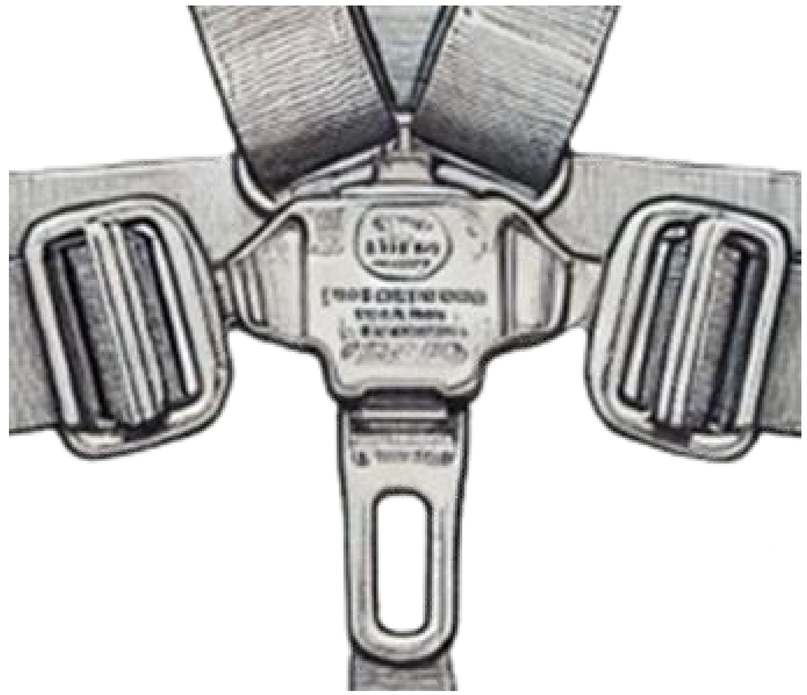
Runs between the legs to prevent from wearer from sliding under the lap belt during an Impact.



5. Buckle Mechanism

Central locking Buckle

A quick release buckle that connects all five straps .



Thread

High strength metal or alloy for durability and Reliability

Material

Ensures easy and Quick Fastening During normal use and emergencies.

Steps for Wearing a 5-Point Harness Seat Belt

1. **Position the Harness**

Sit on the seat and ensure the straps are untangled and correctly aligned.

2. **Secure Shoulder Straps**

Pull the shoulder straps over each shoulder, ensuring they lay flat.

3. **Fasten Waist Straps**

Buckle the waist straps securely across the hips.

4. Attach Groin Strap

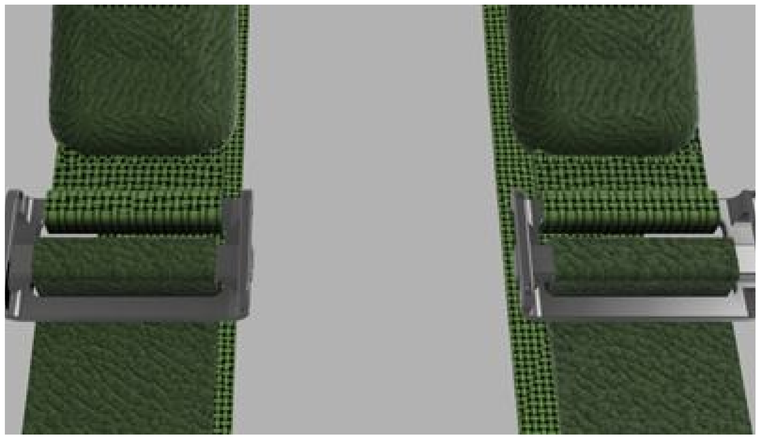
Connect the groin strap to the central buckle for full support.

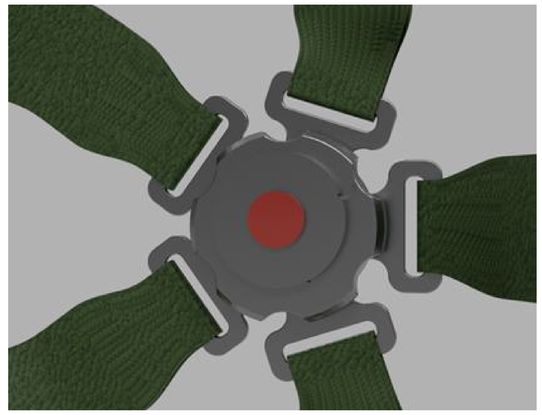
5. Adjust Tightness

Tighten all straps (shoulder, waist, and groin) to ensure a snug and secure fit without discomfort.

6. Double-Check

Confirm all straps are secure and the central buckle is locked properly.





One-Hand Adjustment Mechanism

The seatbelt incorporates a user-friendly, one-hand adjuster that lets users quickly secure or release the straps with minimal effort, providing both convenience and efficiency when adjusting the harness for optimal fit.



Quick-Release Buckle

The seatbelt features an easy-to-operate, push-button quick-release buckle that allows users to swiftly detach the harness without the need for complex maneuvers, ensuring fast and effortless exit in emergency situations.



Anti-Chafe Neck Guard

The shoulder pads are designed with soft, gel-infused edges that adapt to the user's body, preventing neck cutting or chafing during sudden movements. This innovative material not only enhances comfort but also ensures long-term durability and easy cleaning, making the feature both practical and premium.





Adaptive Fit System

The harness includes an adjustable strap tensioning system with sliding shoulder pads, allowing users to customize the fit precisely to their body shape and size. This ensures optimal comfort, prevents slipping or pressure points, and keeps the harness secure during motion.

This seatbelt design integrates key features to address both comfort and safety, aligning perfectly with the design brief. The Quick-Release Buckle and One-Hand Adjustment Mechanism provide users with fast, efficient access and ease of adjustment, ensuring both convenience and security. The Anti-Chafe Neck Guard offers essential neck protection, preventing discomfort during prolonged use, while the Adaptive Fit System allows for personalized adjustments to suit various body types. Together, these features deliver a comprehensive, user-centric solution that enhances comfort, safety, and usability in any vehicle.

Physical Product Making Process

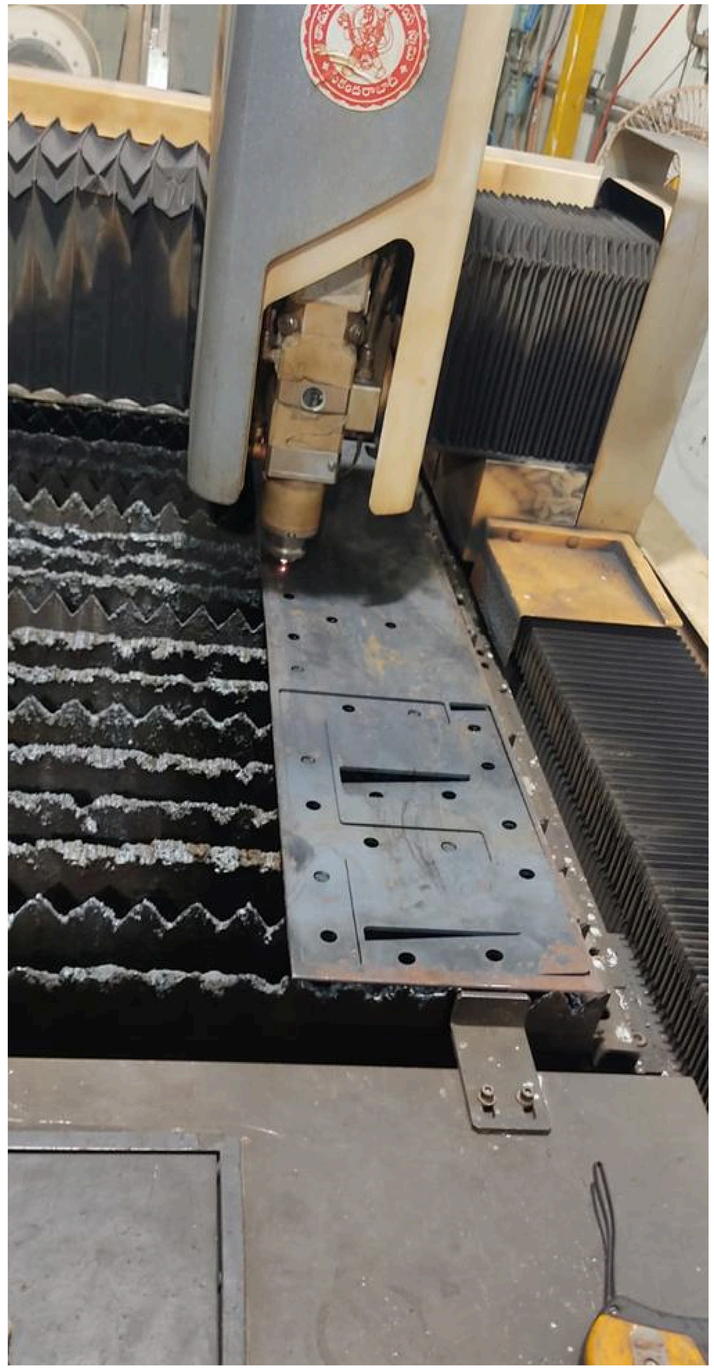
SEARCH FOR THE RODS AND METAL FOR THE STAND





LASER CUTTING

1. Laser cutting was utilized to create precise flaps for the rods in the blast attenuation seat, ensuring accurate dimensions and clean edges.
2. This method allowed intricate designs and tight tolerances, improving the structural integration of the flaps with the seat frame.
3. The precision of laser cutting minimizes material waste and enhances the durability and alignment of components.
4. This process ensures the flaps securely hold the rods, contributing to the overall stability and functionality of the seat.



Preparing channels for the support to seat by using method of cantilever force





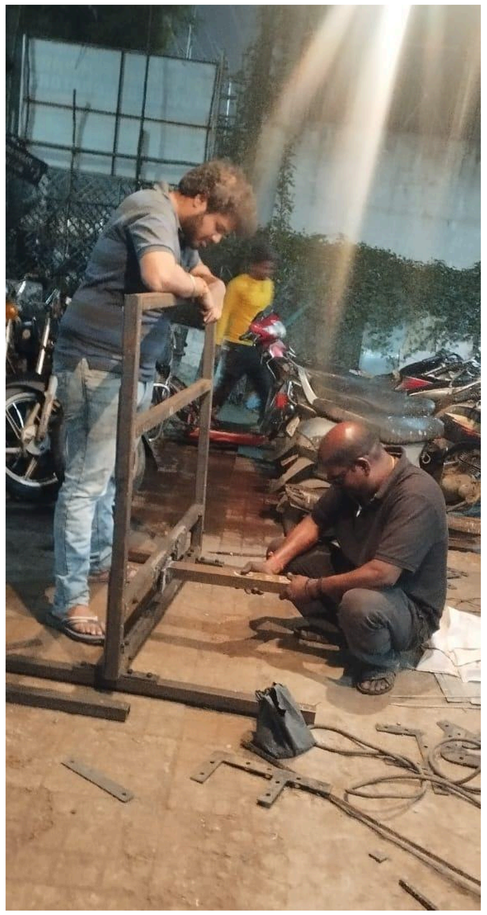
Screws

1. m10 Nut bots and washers
2. socket head bolt(allen bolt)





WELDING OF STAND AND SEAT





THE SEAT PLACEMENT ON STAND



Since I don’t have access to an MRAP vehicle to attach the redesigned blast attenuation seat or permission to bring one to the jury, I’ve created a stand using rods to simulate its placement and functionality. The stand mimics the environment of a truck to provide a realistic context for showcasing the seat. This setup highlights the seat’s design, safety features, and potential applications in real-world scenarios. It ensures the jury can evaluate its innovation and practicality without needing the actual vehicle.

THE OUTPUT WITH 5 HARNESS POINT SEAT BELT



Front View

Isometric View

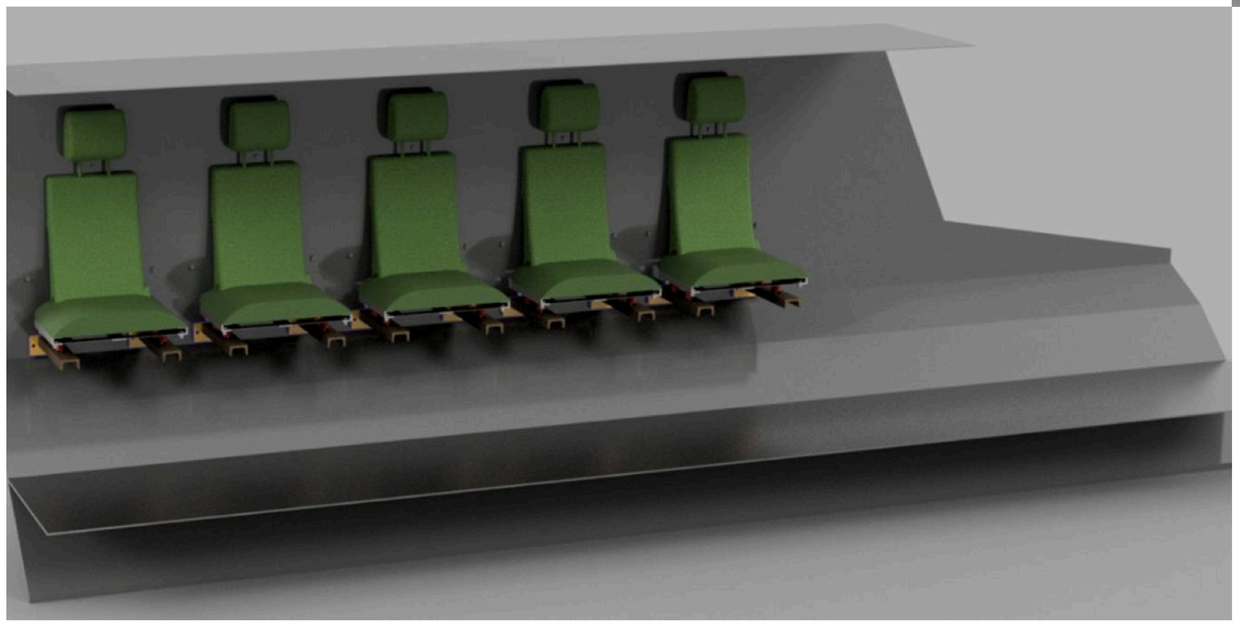




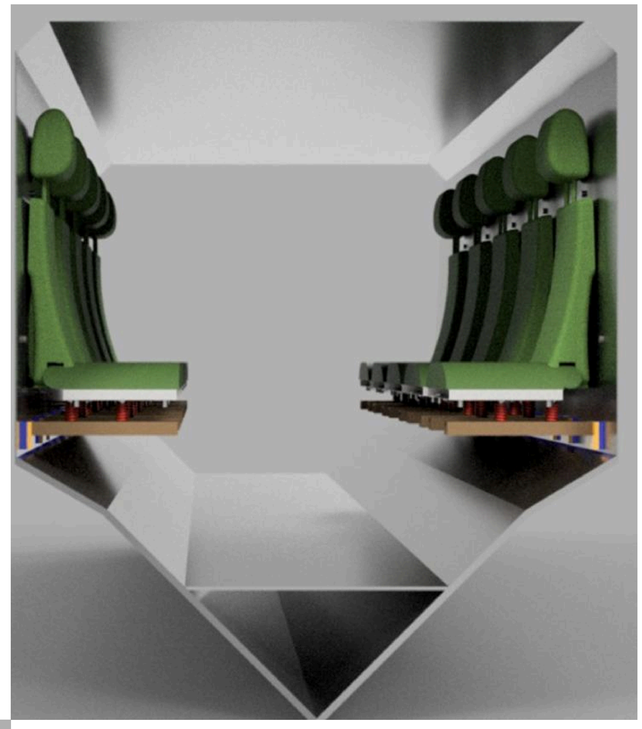
Side View

3D Model

Seat placement



Front View



Side view

Thank you